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(54) **ORGANIC ELECTROLUMINESCENT DEVICE HAVING CONDUCTIVE LAYERS IN A CATHODE LAYER AND AN ELECTRON TRANSPORTING LAYER HAVING A METAL COMPLEX**

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H01L 51/52 (2006.01)
H01L 51/00 (2006.01)

(52) **U.S. Cl.**

CPC ***H01L 51/5092*** (2013.01); ***H01L 51/506*** (2013.01); ***H01L 51/5012*** (2013.01); ***H01L 51/5068*** (2013.01); ***H01L 51/5215*** (2013.01); ***H01L 51/5218*** (2013.01); ***H01L 51/5221*** (2013.01); *H01L 51/0077* (2013.01)

(58) **Field of Classification Search**

None

See application file for complete search history.

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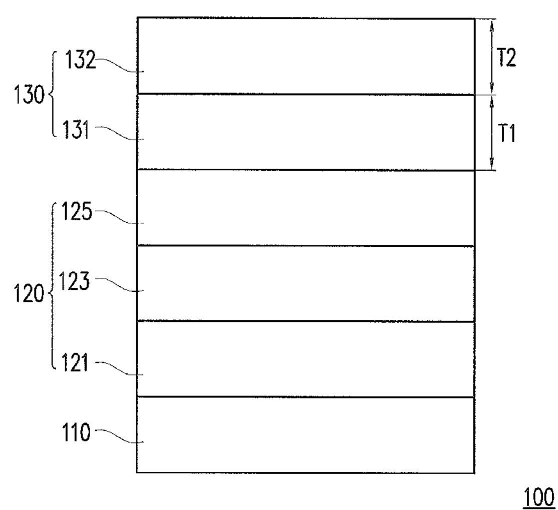
(57) **ABSTRACT**

An organic electroluminescent device including an anode layer, an organic functional layer and a cathode layer is provided. The organic functional layer is disposed between the anode layer and the cathode layer. The cathode layer includes a first conductive layer and a second conductive layer. The first conductive layer is disposed between the organic functional layer and the second conductive layer, and work function of the first conductive layer is higher than work function of the second conductive layer.

16 Claims, 6 Drawing Sheets



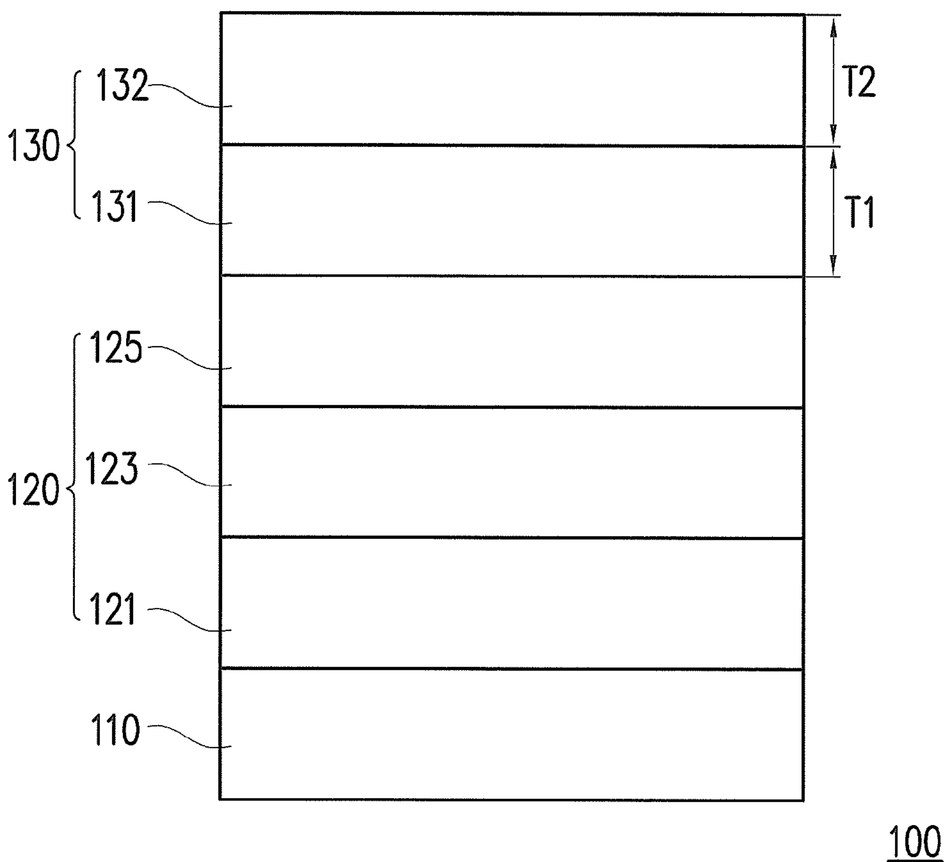


FIG. 1

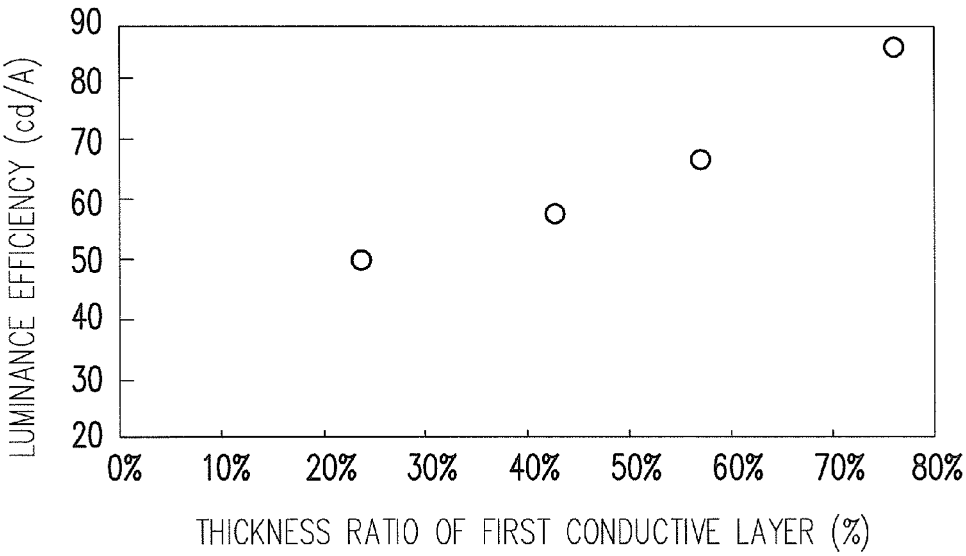

90
80
70
60
50
40
30
20
LUMINANCE EFFICIENCY (cd/A)
0%
10%
20%
30%
40%
50%
60%
70%
80%
THICKNESS RATIO OF FIRST CONDUCTIVE LAYER (%)

FIG. 2A

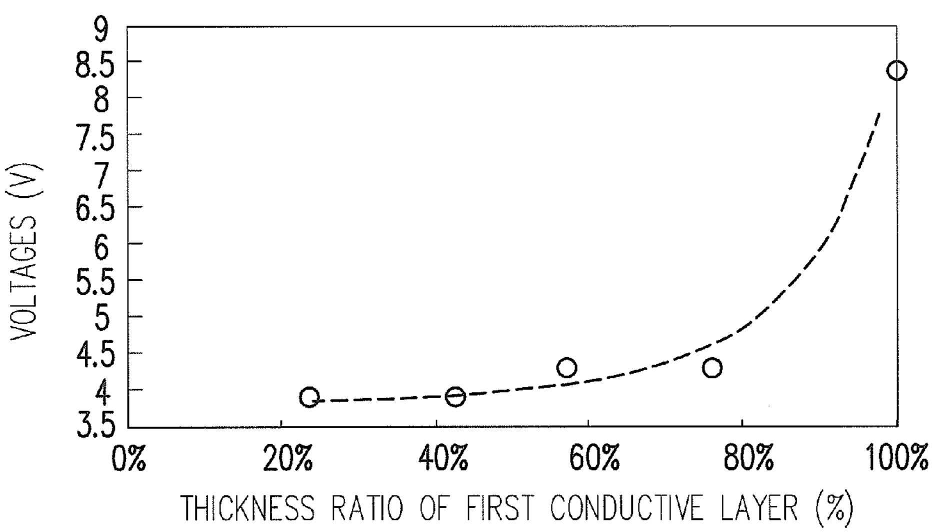

9
8.5
8
7.5
7
6.5
6
5.5
5
4.5
4
3.5
VOLTAGES (V)
0%
20%
40%
60%
80%
100%
THICKNESS RATIO OF FIRST CONDUCTIVE LAYER (%)

FIG. 2B

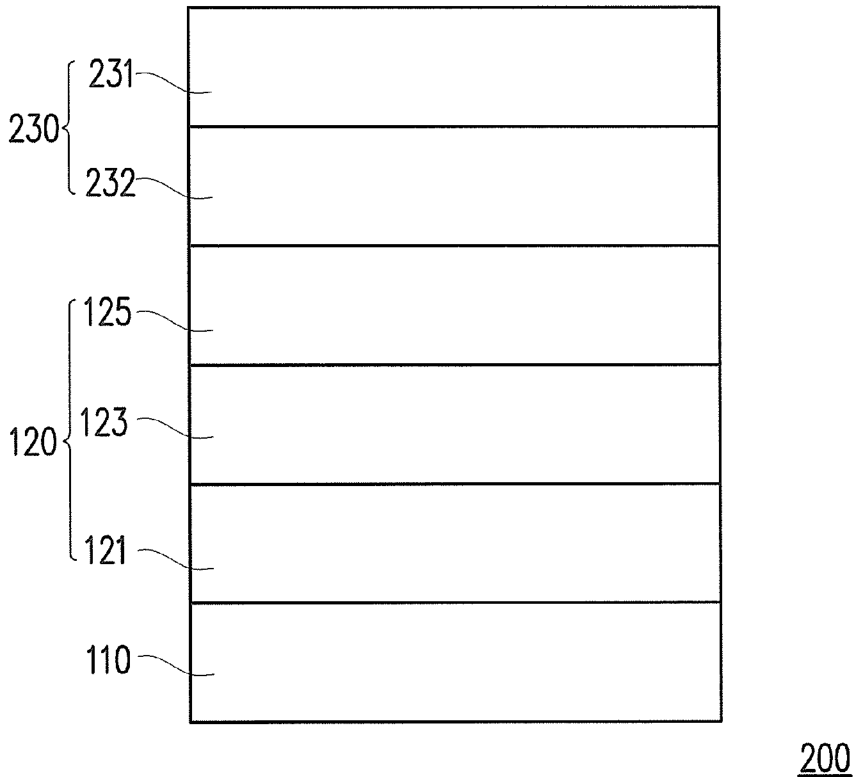


FIG. 3A

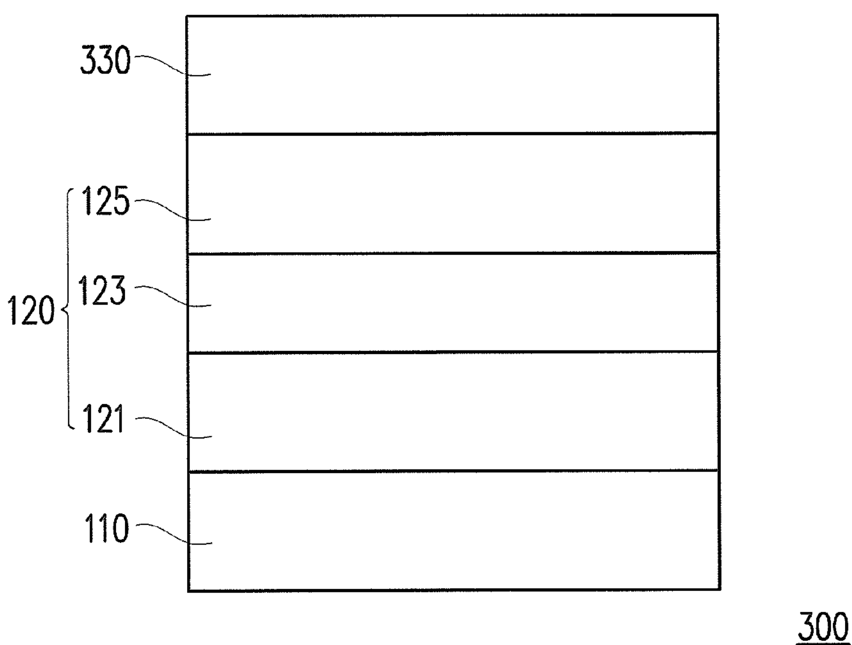


FIG. 3B

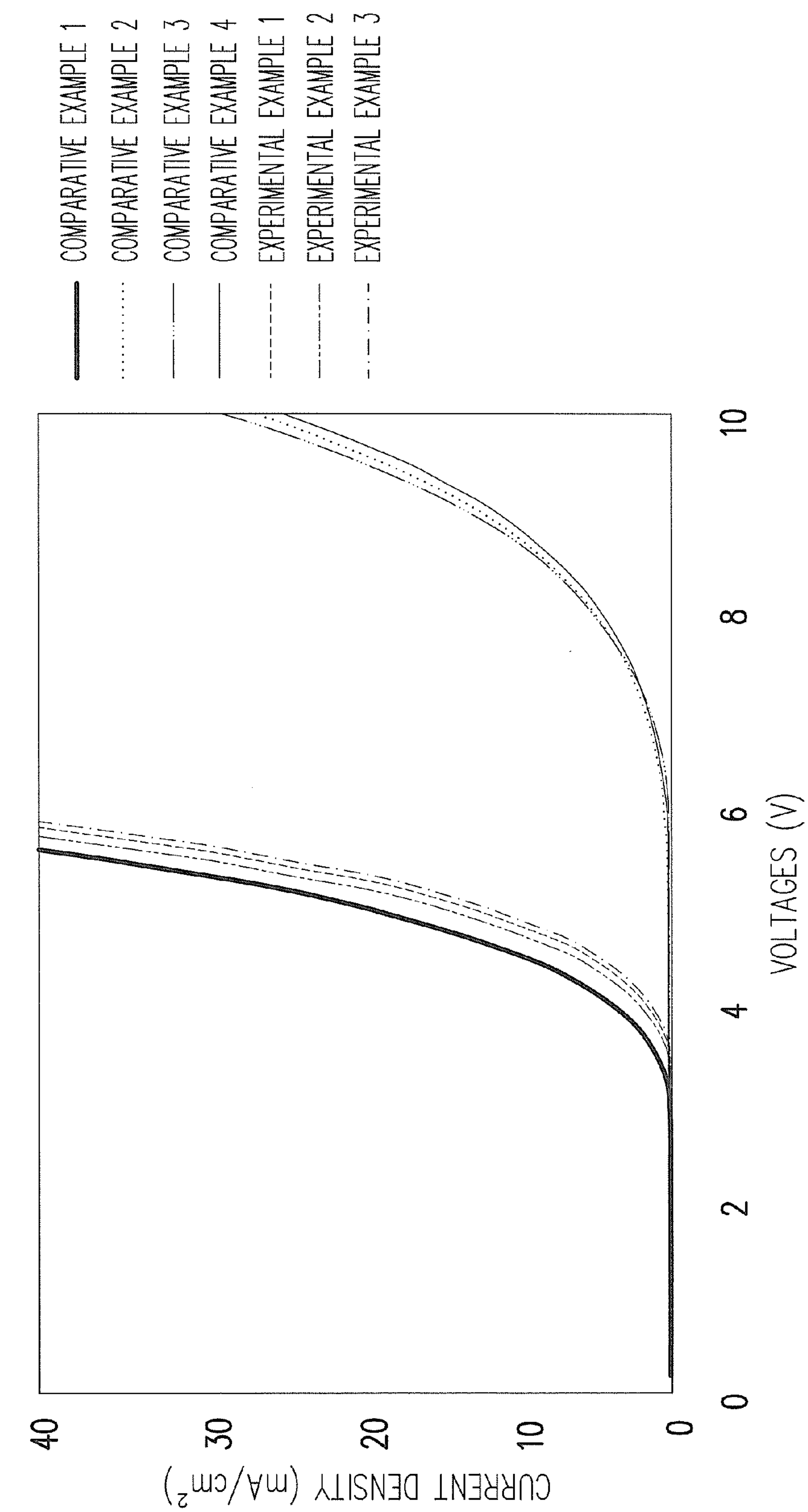

COMPARATIVE EXAMPLE 1
COMPARATIVE EXAMPLE 2
COMPARATIVE EXAMPLE 3
COMPARATIVE EXAMPLE 4
EXPERIMENTAL EXAMPLE 1
EXPERIMENTAL EXAMPLE 2
EXPERIMENTAL EXAMPLE 3
CURRENT DENSITY (mA/cm²)
VOLTAGES (V)
0
10
20
30
40
0
2
4
6
8
10

FIG. 3C

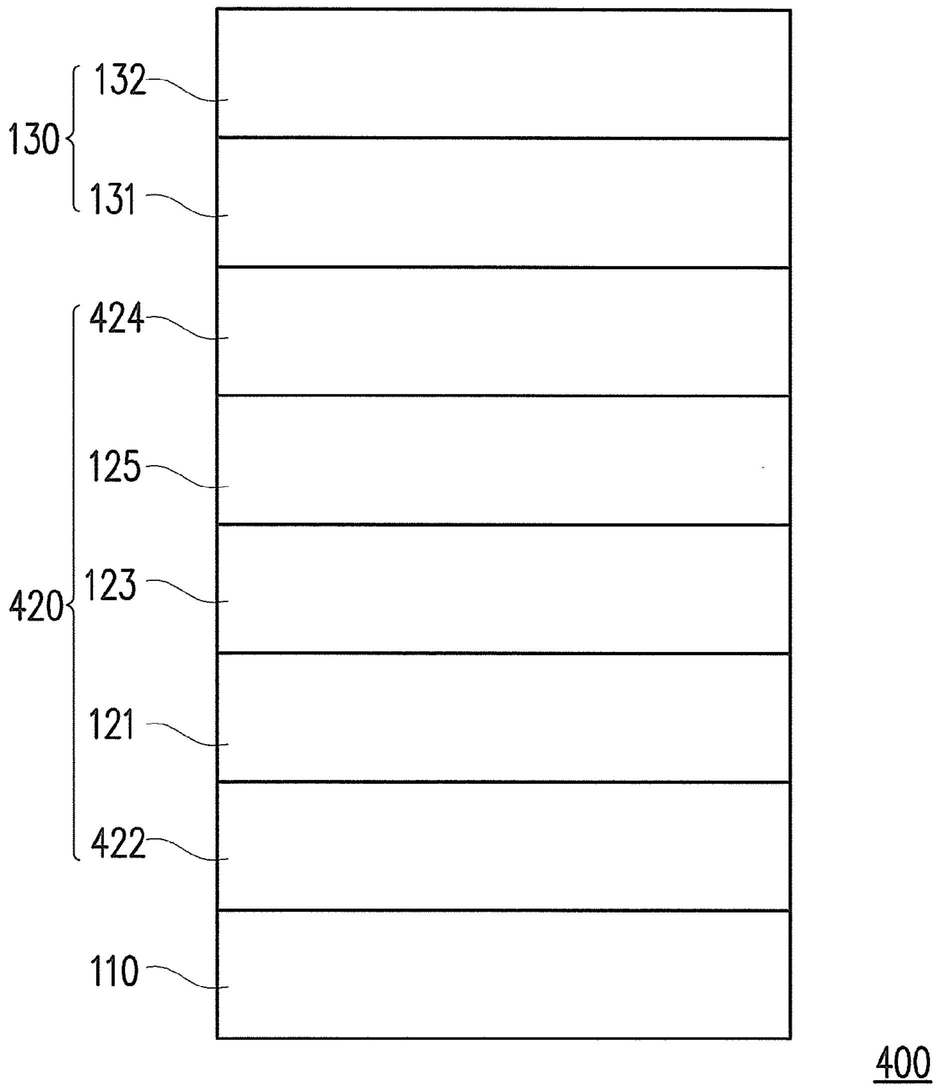


FIG. 4

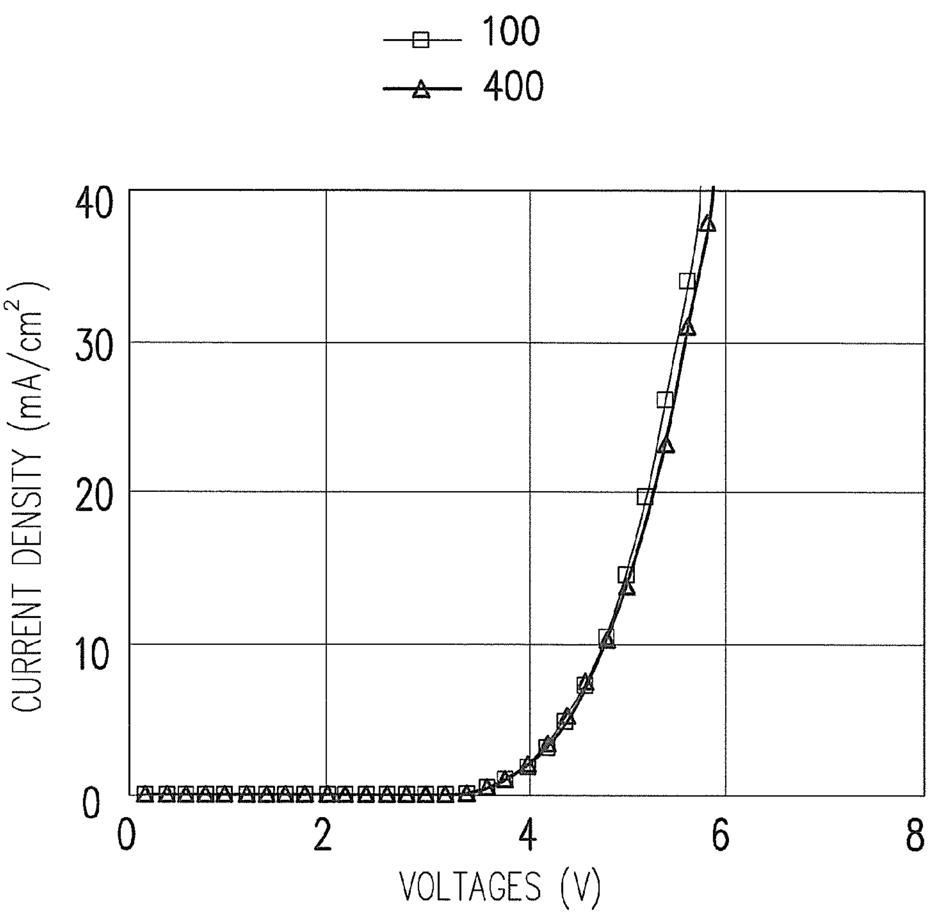


FIG. 5

ORGANIC ELECTROLUMINESCENT DEVICE HAVING CONDUCTIVE LAYERS IN A CATHODE LAYER AND AN ELECTRON TRANSPORTING LAYER HAVING A METAL COMPLEX

CROSS-REFERENCE TO RELATED APPLICATION

This application claims the priority benefit of Taiwan application serial no. 102147595, filed on Dec. 20, 2013. The entirety of the above-mentioned patent application is hereby incorporated by reference herein and made a part of this specification.

FIELD OF THE INVENTION

The invention relates to a luminescence device; more particularly, the invention relates to an organic electroluminescent device.

DESCRIPTION OF RELATED ART

An organic electroluminescent device is a semiconductor device capable of converting electrical energy into optical energy and having high conversion efficiency. Organic electroluminescent devices are wildly used as luminous elements in indication lamps, display panels and optical pick-ups. The organic electroluminescent devices have advantages such as no viewing-angle dependence, simple processing, low production costs, high response speed, wide operation temperature ranges and full color. Therefore, the organic electroluminescent devices meet the demands for modern multi-media displays, and may become the mainstream of the panel display in the next generation.

In general, the organic electroluminescent device includes an anode, an organic electroluminescent layer and a cathode. The luminance mechanism of the organic electroluminescent device works by injecting holes and electrons into the organic electroluminescent layer from the anode and the cathode, respectively. When encountered in the organic electroluminescent layer, the electrons and the holes may recombine to generate photons, and the phenomenon of light emission is generated. In order for the electrons to be successfully injected from electrodes into the organic electroluminescent layer at lower driving voltage, an N-type doped electron transporting layer may further be disposed between the cathode and a light emitting layer, wherein an N-type dopant is usually doped in a material layer during a co-evaporation process. Accordingly, carrier concentration of the electron transporting layer is increased to generate tunneling effects, which facilitates injection of the electrons into the organic electroluminescent layer.

However, if alkali or alkaline earth metal salt having the high activation are used as a material (e.g. N-type dopant) of an electron injection layer, the material (i.e. alkali or alkaline earth metal salt) is not air-stable and may have a shorter lifetime. On the other hand, when an air-stable electron injection material and commonly used cathode material (e.g. silver, magnesium or other alkaline earth elements) are utilized, electrons may not be injected into an organic electroluminescent layer efficiently. Thus, when compared with alkali or alkaline earth metal salt having the high activation, the air-stable electron injection material requires higher driving voltage for driving the organic electroluminescent device, thereby luminance efficiency of the organic electroluminescent device is difficult to be enhanced.

Hence, a consideration of a lifetime and luminance efficiency of the organic electroluminescent device has become one of essential topics for researchers and developers in the field.

SUMMARY OF THE INVENTION

The invention provides an organic electroluminescent device which has favorable luminance efficiency and lifetime.

The organic electroluminescent device of the invention includes an anode layer, an organic functional layer and a cathode layer. The organic functional layer is disposed between the anode layer and the cathode layer. The cathode layer includes a first conductive layer and a second conductive layer. The first conductive layer is disposed between the organic functional layer and the second conductive layer, and work function of the first conductive layer is higher than work function of the second conductive layer.

In view of the above, in the invention, work function of the first conductive layer is set to be higher than work function of the second conductive layer by arranging the first conductive layer in between the organic functional layer and the second conductive layer, such that electrons are successfully injected into the organic electroluminescent layer. Consequently, driving voltage of the organic electroluminescent device can be effectively reduced, and luminance efficiency of the organic electroluminescent device is significantly improved.

To make the aforesaid features and advantages of the invention more comprehensible, several embodiments accompanied with figures are described in detail below to further describe the invention in details.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings are included to provide a further understanding of the invention, and are incorporated in and constitute a part of this specification. The drawings illustrate embodiments of the invention and, together with the description, serve to explain the principles of the invention.

FIG. **1** is a schematic cross-sectional view illustrating an organic electroluminescent device according to an embodiment of the invention.

FIG. **2**A is a graph illustrating luminance efficiency of the organic electroluminescent device of FIG. **1** versus a thickness ratio of the first conductive layer and the cathode layer.

FIG. **2**B is a graph illustrating voltages of the organic electroluminescent device of FIG. **1** versus a thickness ratio of the first conductive layer and the cathode layer.

FIG. **3**A and FIG. **3**B are schematic cross-sectional views illustrating various organic electroluminescent devices according to Comparative Examples of the invention.

FIG. **3**C is a graph illustrating current density versus voltages (I-V curve) in different Embodiments and different Comparative Examples.

FIG. **4** is a schematic cross-sectional view illustrating an organic electroluminescent device according to another embodiment of the invention.

FIG. **5** is a graph illustrating current density versus voltages of the organic electroluminescent devices of FIG. **1** and FIG. **4**.

DETAILED DESCRIPTION OF DISCLOSED EMBODIMENTS

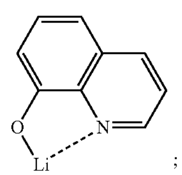
Reference will now be made in detail to the present preferred embodiments of the invention, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers are used in the drawings and the description to refer to the same or like parts.

FIG. **1** is a schematic cross-sectional view illustrating an organic electroluminescent device according to an embodiment of the invention. With reference to FIG. **1**, an organic electroluminescent device **100** of the present embodiment includes an anode layer **110**, an organic functional layer **120** and a cathode layer **130**. For example, the anode layer **110** includes a reflective electrode or a transparent electrode, or stacking layers of a combination thereof. A material of the reflective electrode is, for example, copper (Cu), aluminum (Al), silver (Ag), gold (Au), titanium (Ti), molybdenum (Mo), tungsten (W), chromium (Cr), and an alloy thereof or a stacking layer thereof. The transparent electrode is, for example, a metal oxide layer including indium tin oxide (ITO), indium zinc oxide (IZO), aluminum tin oxide (ATO), aluminum zinc oxide (AZO), indium germanium zinc oxide (IGZO), or any other suitable metal oxide. In other applicable embodiments, the transparent electrode may also be a stacking layer of at least two of the above (metal oxides), or a thin metal layer having high transmittance or thin metal stacking layers.

On the other hand, the organic functional layer **120** of the present embodiment is disposed between the anode layer **110** and the cathode layer **130**. More specifically, the organic functional layer **120** includes a hole transporting layer **121**, an organic electroluminescent layer **123** and an electron transporting layer **125**. For example, the organic electroluminescent layer **123** may be a white light luminescent material layer or a luminescent material layer capable of emitting other specific color lights (e.g., red light, green light, blue light, ultraviolet light, etc). In addition, the hole transporting layer **121** is disposed between the organic electroluminescent layer **123** and the anode layer **110**. The electron transporting layer **125** is disposed between the organic electroluminescent layer **123** and the cathode layer **130**. For example, the electron transporting layer **125** is an N-type doped electron transporting layer. In more detail, the electron transporting layer **125** of the present embodiment is doped with a metal complex compound, and the metal complex compound has at least one of the following chemical structure formulae as shown in Formula 1 to Formula 6.

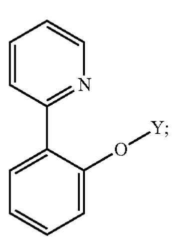
For example, a material of the metal complex compound includes 8-hydroquinolatolithium (Liq) having the following formula:

(Formula 1)



alternatively, the material of the metal complex compound includes a metal salt containing [2-(2-pyridyl)phenolate (PP)], and a formula thereof is as shown below:

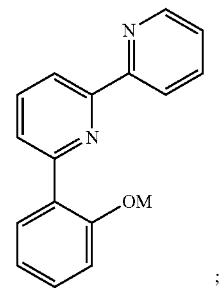
(Formula 2)



wherein Y may be lithium (Li), sodium (Na), potassium (K) or caesium (Cs); namely, the metal complex compound includes [lithium 2-(2-pyridyl)phenolate (LiPP)], [sodium 2-(-pyridyl)phenolate (NaPP)], [potassium 2-(2-pyridyl)phenolate (KPP)], [caesium 2-(2-pyridyl)phenolate (CsPP)];

alternatively, the material of the metal complex compound includes a metal salt containing [2-(20, 20 0-bipyridine-60-yl)phenolate (BPP), and a formula thereof is as shown below:

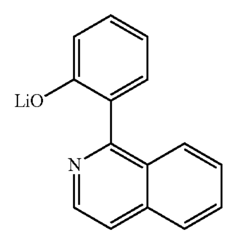
(Formula 3)



wherein M may be lithium (Li) or sodium (Na). Namely, the metal complex compound includes [lithium 2-(20, 20 0-bipyridine-60-yl)phenolate (LiBPP)] or [sodium 2-(20,20 0-bipyridine-60-yl)phenolate (NaBPP)];

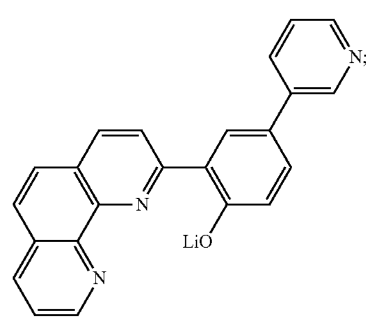
alternatively, the material of the metal complex compound includes [lithium 2-(isoquinoline-10-yl)phenolate (LiIQP)], and a formula thereof is as shown below:

(Formula 4)



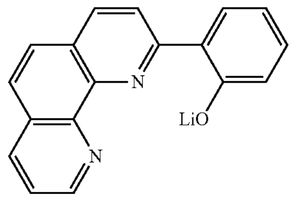
alternatively, the material of the metal complex compound includes {2-[2'-Hydroxyphenyl-5-(pyridyl-3-yl)]phenanthrolinato Lithium (LiPBPy)}, and a formula thereof is as shown below:

(Formula 5)



alternatively, the material of the metal complex compound includes [2-(2'-hydroxyphenyl)phenanthrolinato Lithium (LiPB)], and a formula thereof is as shown below:

(Formula 6)



In light of the foregoing, all of the materials of the metal complex compound have properties such as thermal stability or non-deliquescence that is stable in a common environment. In other words, the electron transporting layer **125** of the present embodiment adopts an electron injection material is air-stable.

In the present embodiment, the cathode **130** includes a first conductive layer **131** and a second conductive layer **132**, and the first conductive layer **131** is disposed between the organic functional layer **120** and the second conductive layer **132**. In the present embodiment, work function of the first conductive layer **131** is higher than work function of the second conductive layer **132**. In particular, work function of the first conductive layer **131** is W**1**, and work function of the second conductive layer **132** is W**2**, wherein 2 eV≤W**2**<4.0 eV, and 4 eV≤W **1**<5.7 eV. For example, a material of the first conductive layer **131** includes silver (Ag) or aluminum (Al), wherein work function of Ag is approximately 4.26 eV, while work function of Al is approximately 4.28 eV. In addition, a material of the second conductive layer **132** includes magnesium (Mg) or calcium (Ca), wherein work function of Mg is approximately 3.66 eV, while work function of Ca is approximately 2.87 eV.

Furthermore, the cathode layer **130** of the present embodiment is formed by stacking the first conductive layer **131** and the second conductive layer **132**, and light absorptivity of the first conductive layer **131** is different from that of the second conductive layer **132**. Therefore, a relation of a thickness ratio between the first conductive layer **131** and the second conductive layer **132** may also affect luminance efficiency and driving voltage at the same time. Further illustrations will be provided in the accompanying FIG. **2**A to FIG. **2**B.

FIG. **2**A is a graph illustrating luminance efficiency of the organic electroluminescent device of FIG. **1** versus a thickness ratio of a first conductive layer in a cathode layer, and FIG. **2**B is a graph illustrating voltages of the organic electroluminescent device of FIG. **1** versus a thickness ratio of a first conductive layer in a cathode layer. The first conductive layer **131** of the present embodiment is, for example, silver (Ag), but the invention is not limited herein. According to FIG. **2**A, the luminance efficiency of the organic electroluminescent device **100** of the present embodiment increases when a thickness ratio of the first conductive layer **131** in the cathode layer **130** increases. However, on the other hand, according to FIG. **2**B, when the thickness ratio of the first conductive layer **131** in the cathode layer **130** is higher than 80%, a trend of acquiring driving voltages may also be rapidly increased. Thus, in the present embodiment, in order to lower driving voltage of the organic electroluminescent device **100** and maintain relatively high luminance efficiency at the same time, the thickness ratio of the first conductive layer **131** of the organic electroluminescent device **100** in the cathode layer **130** is controlled in a range of 60% to 80%. Namely, in the present embodiment, when the first conductive layer **131** of the organic electroluminescent device **100** has a thickness of

T**1** and the second conductive layer **132** has a thickness of T**2**, [T**1**/(T**1**+T**2**)] ranges from 0.6 to 0.8.

As such, in the present embodiment, work function of the first conductive layer **131** is higher than work function of the second conductive layer **132** by arranging the first conductive layer **131** in between the organic functional layer **120** and the second conductive layer **132**, such that electrons are successfully and efficiently injected into the organic electroluminescent layer **123**. Consequently, the driving voltage of the organic electroluminescent device **100** may be effectively reduced, and the luminance efficiency of the organic electroluminescent device **100** is significantly improved. Furthermore, since the electron transporting layer **125** of the present embodiment adopts an air-stable electron injection material, the organic electroluminescent device **100** also has a long life time and is suitable for a mass production.

Further illustrations will be provided in the accompanying FIG. **3**A to FIG. **3**C with the effects of the present embodiment.

FIG. **3**A and FIG. **3**B are schematic cross-sectional views illustrating different organic electroluminescent devices according to Comparative Examples of the invention. With reference to FIG. **3**A and FIG. **3**B, structures of organic electroluminescent devices **200** and **300** are similar to that of the organic electroluminescent device **100** of FIG. **1**, and differences therebetween are described below. In a Comparative Example illustrated in FIG. **3**A, a second conductive layer **232** of a cathode layer **230** of the organic electroluminescent device **200** is disposed between the organic functional layer **120** and a first conductive layer **231**. In a Comparative Example illustrated in FIG. **3**B, a cathode layer **330** of the organic electroluminescent device **300** is a single-layered conductive structure, wherein a material of the cathode layer **330** includes silver (Ag) or aluminum (Al). In other words, in the Comparative Example illustrated in FIG. **3**B, the cathode layer **330** has a higher work function.

FIG. **3**C is a graph illustrating current density versus voltages in Experimental examples and different Comparative Examples. In the graph, the organic electroluminescent device **100** of Experimental example 1 to Experimental example 3 has a structure as shown in FIG. **1**, and the metal complex compound of the electron transporting layer **125** is 8-hydroquinolatolithium (Liq) mentioned above. In addition, materials of the first conductive layer **131** and the second conductive layer **132** in Experimental example 1 are silver (Ag) and calcium (Ca), respectively. Materials of the first conductive layer **131** and the second conductive layer **132** in Experimental example 2 are silver (Ag) and magnesium (Mg), respectively, and materials of the first conductive layer **131** and the second conductive layer **132** in Experimental example 3 are aluminum (Al) and magnesium (Mg), respectively. The first conductive layer **131** and the second conductive layer **132** have thicknesses of 16 nm and 5 nm, respectively. Furthermore, a dosage of the metal complex compound of the electron transporting layer **125** is 40%.

On the other hand, the organic electroluminescent device **200** of Comparative Example 1 to Comparative Example 2 has a structure as shown in FIG. **3**A, and the metal complex compound of the electron transporting layer **125** in Comparative Example 1 is alkali or alkaline earth metal salt having high activation, such as cesium fluoride (CsF), while the metal complex compound of the electron transporting layer **125** in Comparative Example 2 is 8-hydroquinolatolithium (Liq) mentioned above. In addition, the materials of the first conductive layer **231** in Comparative Example 1 to Comparative Example 2 are silver (Ag), while the materials of the second conductive layer **232** are magnesium (Mg); and the first conductive layer **231** and the second conductive layer **232** have thicknesses of 16 nm and 5 nm, respectively. Furthermore, the dosage of the metal complex compound of the electron transporting layer **125** is 40%.

Moreover, the organic electroluminescent device **300** of Comparative Example 3 to Comparative Example 4 has a structure as shown in FIG. **3**B, and the metal complex compound of the electron transporting layer **125** is 8-hydroquinolatolithium (Liq) mentioned above. Additionally, a material of the cathode layer **330** in Comparative Example 3 is silver (Ag), while a material of the cathode layer **330** in Comparative Example 4 is aluminum (Al). The cathode layer has a thickness of 21 nm. Furthermore, the dosage of the metal complex compound of the electron transporting layer **125** is 40%.

According to FIG. **3**C, the organic electroluminescent device **100** in Experimental example 1 to Experimental example 3 having the structure as shown in FIG. **1** can be driven by relatively lower driving voltage when compared with the organic electroluminescent devices **200** and **300** in Comparative Example 2 to Comparatively Example 4. Besides, the organic electroluminescent device **200** in Comparative Example 1 doped with alkali or alkaline earth metal salt having high activation (e.g., CsF) may also be driven by low driving voltage.

However, in the Comparative Example 1, since CsF is a kind of alkali or alkaline earth metal salt having high activation and is not air-stable, as compared with the organic electroluminescent devices **100** having the structure as shown in FIG. **1** in Experimental example 1 to Experimental example 3, the organic electroluminescent device **200** in Comparative Example 1 have a relatively shorter life time. Further illustrations will be provided in the accompanying Table 1.

Table 1 is a comparison table illustrating related data when Comparative Example 1 and Experimental example 2 are applied on a blue light device and a green light device.

TABLE 1

	Blue Light Device			Green Light Device		
	Driving Voltage (V)	Luminance Efficiency (cd/A)	LT95% (hrs)	Driving Voltage (V)	Luminance Efficiency (cd/A)	LT95% (hrs)
Comparative Example 1	4.2	4.4	32	4.0	76.0	210
Experimental example 2	4.5	5.5	120	4.3	91.0	325

In Table 1, brightness provided by the blue light device is 1000 nits, and brightness provided by the green light device is 4000 nits. Values of the driving voltages represent required voltages when the organic electroluminescent devices **100** and **200** are driven under current density of 10 mA/cm^2, respectively. Values in LT95% column represent required hours for brightness to be reduced at 5% under normal working conditions. According to Table 1, in a situation where a driving voltages value of the organic electroluminescent device **200** in Comparative Example 1 is similar to that of the organic electroluminescent device **100** in Experimental example 2, the organic electroluminescent device **100** in Experimental example 2 has better luminance efficiency and a longer life time.

FIG. **4** is a schematic cross-sectional view illustrating an organic electroluminescent device according to another embodiment of the invention. With reference to FIG. **4**, an organic electroluminescent device **400** of the present embodiment is similar to the organic electroluminescent device **100** of FIG. **1** except that: an organic functional layer **420** of the organic electroluminescent device **400** of the present embodiment further includes an electron injection layer **424** and an hole injection layer **422**, wherein the electron injection layer **424** is disposed between the electron transporting layer **125** and the cathode layer **130**, and the hole injection layer **422** is disposed between the hole transporting layer **121** and the anode layer **110**. For example, the electron injection layer **424** of the present embodiment is a metal complex layer. However, the invention is not limited herein. In other embodiments, the electron injection layer **424** may also be doped with a metal complex compound.

FIG. **5** is a graph illustrating current density versus voltages of the organic electroluminescent devices of FIG. **1** and FIG. **4**. According to FIG. **5**, the organic electroluminescent devices **100** and **400** of FIG. **1** and FIG. **4** have similar curves of current density versus voltages. Namely, under the same condition, the organic electroluminescent device **400** may achieve optical or electrical properties similar to those achieved by the organic electroluminescent device **100**. Thus, the organic electroluminescent device **400** also has advantages similar to those of the organic electroluminescent device **100**, and a reiteration is omitted herein.

In view of the above, in the invention, work function of the first conductive layer is set to be higher than work function of the second conductive layer by arranging the first conductive layer in between the organic functional layer and the second conductive layer, such that electrons are successfully and efficiently injected into the organic electroluminescent layer. Consequently, the driving voltages of the organic electroluminescent device are effectively reduced, and the luminance efficiency of the organic electroluminescent device is advantageously improved. Furthermore, since the electron transporting layer of the present embodiment adopts the air-stable electron injection material, the organic electroluminescent device also has an excellent long life time and is suitable for a mass production.

Although the invention has been disclosed with reference to the aforesaid embodiments, they are not intended to limit the invention. It will be apparent to those skilled in the art that various modifications and variations can be made to the structure of the disclosed embodiments without departing from the scope or spirit of the invention. In view of the foregoing, it is intended that the disclosure cover modifications and variations of the specification provided they fall within the scope of the following claims and their equivalents.

What is claimed is:

1. An organic electroluminescent device, comprising:

an anode layer;

an organic functional layer, comprising an organic electroluminescent layer and an electron transporting layer, wherein the organic electroluminescent layer is disposed between the anode layer and the electron transporting layer; and

a cathode layer, the organic functional layer being disposed between the anode layer and the cathode layer, and the cathode layer being consisting of:

a first conductive layer, wherein the first conductive layer is a single layer made from a single material; and

a second conductive layer, the first conductive layer being disposed between the electron transporting layer and the second conductive layer, wherein the first conductive layer is in physical contact with the electron transporting layer and the second conductive layer, the electron transporting layer is doped with a metal complex compound, and work function of the first conductive layer being higher than work function of the second conductive layer.

2. The organic electroluminescent device as claimed in claim **1**, wherein the anode layer comprises a reflective electrode or a transparent electrode, or stack layers of a combination thereof.

3. The organic electroluminescent device as claimed in claim **1**, wherein the organic functional layer further comprises a hole transporting layer disposed between the organic electroluminescent layer and the anode layer.

4. The organic electroluminescent device as claimed in claim **1**, wherein the metal complex compound comprises a metal complex compound of lithium (Li), sodium (Na), potassium (K), or caesium (Cs).

5. The organic electroluminescent device as claimed in claim **1**, wherein the metal complex compound comprises 8-hydroquinolatolithium (Liq), lithium 2-(2-pyridyl)phenolate (LiPP), sodium 2-(2-pyridyl)phenolate (NaPP), potassium 2-(2-pyridyl)phenolate (KPP), caesium 2-(2-pyridyl) phenolate (CsPP), lithium 2-(20, 20 0-bipyridine-60-yl) phenolate (LiBPP), sodium 2-(20, 20 0-bipyridine-60-yl) phenolate (NaBPP), lithium 2-(isoquinoline-10-yl)phenolate (LiIQP), 2-[2'-Hydroxyphenyl-5-(pyridyl-3-yl)]phenanthrolinato Lithium (LiPBPy) or 2-(2'-hydroxyphenyl)phenanthrolinato Lithium (LiPB).

6. The organic electroluminescent device as claimed in claim **1**, wherein the electron transporting layer is an N-type doped electron transporting layer.

7. The organic electroluminescent device as claimed in claim **1**, wherein work function of the first conductive layer is W**1**, work function of the second conductive layer is W**2**, and 2 eV≤W**2**<4.0 eV, and 4 eV≤W**1**<5.7 eV.

8. The organic electroluminescent device as claimed in claim **1**, wherein a material of the first conductive layer comprises silver (Ag) or aluminum (Al), and a material of the second conductive layer comprises magnesium (Mg) or calcium (Ca).

9. The organic electroluminescent device as claimed in claim **1**, wherein the first conductive layer has a thickness of T**1**, and the second conductive layer has a thickness of T**2**, and [T**1**/(T**1**+T**2**)] ranges from 0.6 to 0.8.

10. An organic electroluminescent device, comprising:

an anode layer;

an organic functional layer; and

a cathode layer, the organic functional layer being disposed between the anode layer and the cathode layer, and the cathode layer being consisting of:

a first conductive layer, wherein the first conductive layer is a single layer made from a single material; and

a second conductive layer, the first conductive layer being disposed between the organic functional layer and the second conductive layer, wherein the first conductive layer is in contact with the organic functional layer and the second conductive layer, the organic functional layer comprises a layer doped with a metal complex compound, and work function of the first conductive layer being higher than work function of the second conductive layer.

11. The organic electroluminescent device as claimed in claim **10**, wherein the layer doped with a metal complex compound is in contact with the first conductive layer.

12. The organic electroluminescent device as claimed in claim **10**, wherein the metal complex compound comprises a metal complex compound of lithium (Li), sodium (Na), potassium (K), or caesium (Cs).

13. The organic electroluminescent device as claimed in claim **10**, wherein the metal complex compound comprises 8-hydroquinolatolithium (Liq), lithium 2-(2-pyridyl)phenolate (LiPP), sodium 2-(2-pyridyl)phenolate (NaPP), potassium 2-(2-pyridyl)phenolate (KPP), caesium 2-(2-pyridyl) phenolate (CsPP), lithium 2-(20, 20 0-bipyridine-60-yl) phenolate (LiBPP), sodium 2-(20, 20 0-bipyridine-60-yl) phenolate (NaBPP), lithium 2-(isoquinoline-10-yl)phenolate (LiIQP), 2-[2'-Hydroxyphenyl-5-(pyridyl-3-yl)]phenanthrolinato Lithium (LiPBPy) or 2-(2'-hydroxyphenyl)phenanthrolinato Lithium (LiPB).

14. The organic electroluminescent device as claimed in claim **10**, wherein work function of the first conductive layer is W**1**, work function of the second conductive layer is W**2**, and 2 eV<W**2**<4.0 eV, and 4 eV<W**1**<5.7 eV.

15. The organic electroluminescent device as claimed in claim **10**, wherein a material of the first conductive layer comprises silver (Ag) or aluminum (Al), and a material of the second conductive layer comprises magnesium (Mg) or calcium (Ca).

16. The organic electroluminescent device as claimed in claim **10**, wherein the first conductive layer has a thickness of T**1**, and the second conductive layer has a thickness of T**2**, and [T**1**/(T**1**+T**2**)] ranges from 0.6 to 0.8.

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